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WEATHER CONTROLS OVER THE FIGHTING IN MESOPOTAMIA, IN PALESTINE, AND NEAR THE SUEZ CANAL¹

By Professor ROBERT DE C. WARD

HARVARD UNIVERSITY

WHEN the British Expedition invaded Mesopotamia from the Persian Gulf in 1915, the fighting was carried into a region whose climate and weather differ markedly from those which characterize any other portion of the war area, although they resemble, in some respects, the conditions in Gallipoli and in the region about the Suez Canal. Mesopotamia is a country of aridity; of intense summer heat; of deserts and steppes; of relatively mild winters; of cold-season rains. It has a good deal in common with the Mediterranean countries, but its rainfall is less, and its summer heat greater. It is a country where campaigning is best in winter. There is then a better water supply, and the temperatures are on the whole favorable for the movement and the comfort of the troops.² Occasional

TEMPERATURES AT BAGDAD (LAT. 33° 21' N.;
LONG. 44° 26' E., ALT. 60 METERS)

| | |
|--------------------|----------|
| January | 48.7° F. |
| August | 92.5° |
| Mean annual | 71.2° |
| Mean minimum | 21.9° |
| Mean maximum | 119.5° |

colder spells, with northwest winds, lower the thermometer several degrees below freezing; frosts occur, and snow falls locally. In the region of the lower Euphrates and Tigris snow is rare, but it is common in upper Mesopotamia, and on

¹ This account is brought down to February 10, 1918.

² The essential temperature data for Bagdad may be taken as fairly representative of the region in which most of the fighting has taken place.

the mountains. Hail falls infrequently, but occasionally occurs over considerable areas. The winter months bring the "rainy season." The designation is misleading unless it is clear that a *relatively* wet season is meant. The total mean annual rainfall is only about 8 or 9 inches, and some years but half as much. Precipitation, as usual, is heavier on the mountains than on the arid lowlands. The rains fall between October and May. This is also the cloudiest season. The remaining months are practically rainless. Showers are very rare in summer. At Bagdad, February or March is the rainiest month (1 inch to 1.5 inches). Of great importance in the life and development of Mesopotamia are the annual floods, which, being dependent on the rains, come in late winter and spring, and are generally at a maximum in March and April. The lowest water is in late summer and early autumn.

The summers are excessively hot. The highest temperatures average between 115° and 122° F., and in individual cases they may even run a few degrees higher. The sun blazes in a cloudless sky of wonderful blue. The air is clean and clear, except when filled with dust. The every-day routine of life is regulated by the temperature. During the hottest hours of the day, the natives take refuge in underground rooms in which the temperatures may be 10°–25° lower than outdoors. The air is, however, "dead" and close. In the houses of the well-to-do various cooling devices are resorted to. Water is sprinkled abundantly in the courtyards. The cooler, fresher air of early morning and evening brings the people out on to the flat roofs of their houses, where meals are eaten and the most comfortable conditions for sleeping may be found. Still worse than the relatively dry heat of central Mesopotamia is the "hothouse" air of the region at the head of the Persian Gulf, where damp southerly and southeasterly winds bring almost unbearable conditions of stifling muggy air.

Mesopotamia has not always been the desert which it is to-day. In the old days it was the home of powerful peoples; the center of ancient civilization. The Garden of Eden is generally supposed to have been here. If properly conserved and wisely distributed, there is water enough in Mesopotamia to turn immense areas of desert into green fields of cereals and of cotton, and into blossoming orchards. There is no reason, so far as water supply is concerned, why Mesopotamia should be a "brown wilderness, vast and uninhabited; the abiding place of wind, and dust and silence," as a recent writer has de-

scribed it.³ No "change" of climate is responsible for the present condition. The incapacity of the Turkish government is the sole source of the trouble. Plans for the reclamation of Mesopotamia had been drawn, before the war, by Sir William Willcocks, already famous for his irrigation work in Egypt.⁴ It appears that the ancient irrigation canals were well placed and can be repaired and again utilized, while new canals and ditches can be constructed without very great cost. It is reported that English engineers have recently built a barrage on the lower Tigris which has made possible the irrigation of a piece of land where enough cereals, dairy products and poultry are being supplied to feed the British Expeditionary Force. The general situation as to the present neglect of the available water supply of Mesopotamia is strikingly emphasized by Sir William Willcocks when he speaks of "the exhibition of two mighty rivers flowing between deserts to waste themselves in the sea for nine months of the year, and desolating everything in their way during the remaining three."

The foregoing facts regarding the climate of Mesopotamia make it clear that meteorological handicaps a military expedition into that country must inevitably meet. The reports, both official and non-official, regarding the military operations during the Mesopotamian campaign have given abundant illustration of the importance of the weather factor in warfare in that historic region, once so prosperous, now so decayed and backward. The intense heat of summer; the lack of water; the cold-season rains and storms; the floods; the cold spells of winter—all, as was to be expected, played their part. It was obvious from the first that great difficulty would result from the aridity of Mesopotamia. The former canal system long ago fell into disuse, and water can only be obtained from the rivers, many of which dry up completely in the hot summers.

Very little news came through regarding the early stages of the British invasion. It will be remembered that General Townshend's column, proceeding up the Tigris, captured the historic city of Ctesiphon, but partly because of lack of water was obliged to retire when within a short distance (about twenty miles) of Bagdad. There were marches "over burning sands." There was intense suffering from thirst. The army had to be kept near the river, where there was a plentiful supply of water; but, as one of the medical officers wrote, "neat

³ El Hamran, "The End of the Year: Mesopotamia, 1915." *Blackwood's Mag.*, Vol. 201, May, 1917.

⁴ "The Irrigation of Mesopotamia," London, 1911.

Tigris is not a very healthy drink at the best of times." Temperatures of 128° to 130° F. were reported, but these are doubtless a few degrees too high, owing to poor exposure of the thermometers. An officer in the Royal Field Artillery wrote of temperatures of 110°, and of the exhaustion of the infantry in the hot sun. "We can not carry nearly enough water," he notes, "and one's tongue swells when the sun is up." The heat was "about the limit of human endurance." In the hospital tents temperatures of 130° were reported, and this may easily have been the case. Under such conditions "the suffering of the sick and wounded was distressing to contemplate." On an afternoon march one officer reported that his goggles became so hot that they blistered his face, even under the shade of his helmet. The men fell ill as a result of the excessive heat, and of the bad water.

The expedition under General Aylmer, going to the relief of the beleaguered troops in Kut-el-Amara, met with serious difficulties on account of the rains.⁵ A London despatch (January 22, 1916) mentions a "hurricane" (really only a winter storm), which had made navigation and other operations most difficult. The Tigris rose rapidly. On January 24, 1916, it was reported that the river had risen seven feet in forty-eight hours at Kut, "preventing all troop movements by land." "At this season," one despatch noted, "the Tigris is very full, with a strong current," the reference being to the winter high-water stage, resulting from the rains at that season. With northwesterly winds it was reported as "bitterly cold." It is reasonably certain that the temperatures were not many degrees (perhaps 10°-15° F.) below freezing, but with a strong wind, after the excessive heat of the summer, the words "bitterly cold" doubtless express what the men really felt.

The British surrender at Kut-el-Amara came as a distinct and most depressing shock. Lord Kitchener, who was then War Minister, emphatically stated that adverse elements alone were responsible for the lack of success. Constant rains and the resulting floods had not only impeded the advance of the Relief Expedition, but had compelled, in place of a turning movement, a direct attack upon an impossibly narrow front. The House of Lords, the War Minister said in his speech before that body, 'would not fail to realize how tense was the strain upon the troops. For more than twenty weeks they had held

⁵ The "first rains of the year" were reported November 25, 1915. Mention was made of a succession of heavy storms.

their positions under conditions of abnormal climatic difficulty and on rations calculated for protraction to the furthest period until imminent starvation compelled capitulation.' Several interesting meteorological conditions attracted the attention of the besieged troops in Kut-el-Amara.⁶

The winter rains, described in such terms as "several days of steady rain"—it "poured"—"two days rain"—"more rain"; the mud; the cold, with 8° or more "of frost"—"hoar frost in the morning"—"bitter cold"—"very cold"—"clear bracing air"; the late winter and spring floods, in one instance driving the men from the trenches; the snow-clad hills: all these receive mention. At the end of March, according to the Kut observers, a violent thunderstorm, with heavy rain, occurred, and a Berlin despatch reports that during a thunderstorm in March the principal British camp was struck by lightning and "extensive damage was done." An especially interesting occurrence was a "deluge of hail" (April 3), with stones one half an inch in diameter, the record stating that "it was well to get under shelter, for they hurt." On April 12, 1916, General Lake reported that water was driven by a north-west gale into some of the enemy's trenches, forcing the Turks out to a new position. Many engagements were fought with the men up to their hips in water. Of the sufferings of the British during the Kut-el-Amara campaign an English officer writes as follows:

Nothing that has been printed about the hardships of that ill-fated expedition came up to the conditions the men had to contend with. . . . The water was thick with mud and unfit to drink, but it was impossible to keep some of the men from slaking their thirst, which resulted in their death by cholera. When I was down with fever the heat in my tent was 117°, and there was nothing to eat but stodgy porridge; no medicines or medical comforts of any kind. . . . For hundreds of miles there was not a blade of grass, and no chance to get cover from the scorching sun or the enemy's guns. . . . Flies gave us the most trouble in Mesopotamia, where they are worse than in any part of the eastern countries. They settled so thickly on the faces and arms of the men that it looked as if they were wearing armor. One fly out of every twenty appeared to be able to bite and inflict a severe sting.

With the advance of spring (1916) the heat became greater. On May 20 General Lake reported: "The weather is intensely hot and trying," with temperatures over 100° in the shade. It was so hot (over 120°) in July that both British and Russian troops had to remain inactive for many days. The Russians retreated almost 80 miles in the Bagdad region. The principal

⁶ C. B., "Besieged in Kut and After," *Blackwood's Mag.*, Vol. 201, May, 1917.

reason assigned for this retreat was the heat, which made campaigning very difficult. It was reported that the Russians planned to remain in the cooler hill country until the temperature conditions made the resumption of the advance expedient. On July 16, 1916, Sir Victor Horsey, the eminent surgeon, died of heat stroke.

Mesopotamia is obviously a region where campaigning is easier in winter than in summer. After several months of inactivity on account of the intense heat, the British Army resumed operations about the middle of September (1917). It appears that supplies of munitions and food were sent forward by the Germans along the Bagdad Railway during the dry summer months, before the wet season might make transportation difficult. Rains, coming as was to be expected, hampered the movements of the British troops (late December, 1916). Late in February (1917), heavy rains brought the Tigris to flood level, and made it difficult to move troops, this being the normal time of year for high water. It was clear that the British ought to advance to Bagdad and seize the railway before the hot weather came on. In the House of Commons on March 12, 1917, Mr. Bonar Law, in announcing the fall of Bagdad, said:

Notwithstanding heat and dust the British made a brilliant march toward Bagdad.

The pursuit of the Turks "was conducted in a country destitute of supplies, despite the commencement of summer heat." General Maude reported that "during the recent fighting, fierce gales and blinding dust storms, the lack of water away from the river, and the vigorous pursuit, made the operations arduous."⁷

Late in March (31st) the British and Russian troops, in their converging march toward Khanikin, had difficulty because of wet snow. An unusual occurrence was reported on April 10, when British fighting in Mesopotamia "had to be temporarily suspended owing to a mirage, but upon this lifting, our offense continued." The intense heat constantly interfered with the activity of the troops. On April 13 the heat "rendered the task of keeping in touch with the retreating enemy difficult."

As a whole it is evident that both British and Russians did their best (until the Revolution demoralized the Russian

⁷ A despatch dated March 17 notes the withdrawal of the Russian troops to a town on the Persian border north of Bagdad on account of the heat, which made a retreat to the mountains advisable.

troops) to bring the campaign in Mesopotamia to a successful conclusion before the intense summer heat and lack of water made operations more difficult, if not impossible.⁸ The preparations for the 1917 campaign were far ahead of those of 1916. Ice plants; refrigerating barges for meat; hospital ships with complete electrical equipment for lighting, cooling and ventilation; transportation, etc., were all carefully planned for.

The soil, the rain, the climate, the floods, the flies and the heat combine to make the conduct of a campaign in the Tigris valley during the summer months a task of stupendous difficulty. These difficulties are being tackled and overcome with success.

There could be only very slight activity during the hot season. One of the few reports (July 11, 1917) mentions a British advance which was broken off owing to the extreme heat. A despatch from Washington, July 12, noted Turkish preparations for a campaign for the recovery of Bagdad when cooler weather set in in the fall (1917), adding, "the heat in Mesopotamia at present makes a campaign on a grand scale almost impossible."

Bagdad was taken in March, 1917. After the end of April there has apparently been comparatively little fighting of importance. The heat of the summer, the withdrawal of the Russians, and the British campaign in Palestine doubtless, in part at least, help to explain this relative lull. One despatch mentioned the deaths of many of the British officers and men who, having surrendered to the Turks at Kut-el-Amara (April, 1916), were marched hundreds of miles into the interior. The change from the heat of the Mesopotamian lowlands to the cold of a higher altitude and of a more northern latitude must surely have caused great suffering among these men.

In the spring of 1917, the British extended their campaign into Palestine, a region very rich in historical interest, whose possession is of the greatest military importance to England. The climate of Palestine merits special attention at the present time, not only because of the immediate interest of the cam-

⁸ What has become of the Russian Army in Mesopotamia is still more or less of a mystery. The cooperation of Russian and British troops before the fall of Bagdad promised great things for the future. The complete and speedy subjugation of Mesopotamia, a victorious march on Constantinople, and the fall of the Turkish capital, seemed quite on the cards. But the Russian Army has vanished. As lately as last April (1917), after the Revolution, the Russian soldiers were actively fighting the Turks in Mesopotamia. Early in April they captured Khanikin. Since then there is no definite news of the Army of which so much was expected.

paign there, but also in view of the discussion as to the future of the region as a home for the Jewish people.⁹

The country lies roughly between Lats. 31° and 33° N. It is long and rather narrow. The Mediterranean lies on the west, the Syrian Desert on the east. The Jordan-Dead Sea depression cuts through it from north to south. Rough hilly tablelands lie to the east and west of this valley. On the east, these slope to the desert. On the west, to the Mediterranean. Palestine has what is known among climatologists as a "Mediterranean climate," and has much in common with the whole extended region bordering upon the Mediterranean Sea. It lies in the so-called "Subtropical Belt," at the equatorward margin of the "Temperate" Zone. The countries lying within these belts are far enough from the equator to escape continued high temperatures throughout the year, yet near enough to it to be spared the extreme cold of the higher latitudes. Their rainfall régime is alternately that of the prevailing westerly winds, which prevail on their poleward side, and of the trades, which blow on their equatorward margin. They are thus associated, now with the "Temperate" and now with the Tropical Zones. In winter, following the sun, the equatorward migration of the great pressure and wind systems brings these latitudes under the control of the "prevailing westerlies," whose irregular storms, most frequent during the colder months, give a generally moderate winter precipitation. These rains are not steady and continuous, but are separated by spells of fine, sunny weather. In summer, when, following the sun, the trade winds are extended polewards, dry and nearly continuous fair weather prevails, with general northerly winds.

It is essential, in dealing with the climate of Palestine, to bear in mind the three general topographic subdivisions of the country, the seacoast, the "hill country" of the interior, and the depression of the Jordan and of the Dead Sea. In the north, the central tableland reaches altitudes of 10,000 feet, and over, close to the sea in the mountains of Lebanon. Farther south, there are fertile plains between the hill country and the sea. The coast stations, illustrated by Gaza and Jaffa, have mean midwinter (January) temperatures of between 50° and 55° F., and mean midsummer (August) temperatures of

⁹ There are several published accounts of the climate of Palestine. One of the most recent is that of F. M. Exner, "Zum Klima von Palästina," *Zeitschr. Deutsch. Palästina Ver.*, Vol. 33, 1910, pp. 107. Also J. von Hann, "Handbuch der Klimatologie," 3d ed., Vol. 3, Stuttgart, 1911, pp. 90-99.

75° to a little over 80° F. The hill stations, at elevations of about 1,500 to 3,000 feet, as shown by the records for Jerusalem, Nazareth and Hebron, have from 45° to 50° in January, and from a little over 70° to a little under 80° in August. The effect of the altitude in lowering the mean temperatures is thus seen to average about 5° F. The Jordan Valley, as indicated by the records for Tiberias and Jericho, has mean midwinter (January) temperatures of just under 55°, and mean midsummer (August) temperatures of 85°–90°.¹⁰

In winter, the lowest temperatures usually fall to freezing, or a few degrees below, except at altitudes below about 1,000–1,500 ft., on the coast, and in the Jordan Valley. In individual years they may even fall several degrees below 32°. Jerusalem has had a minimum of 21.2°. In the 10-year period 1896–1907, Jerusalem averaged 3.6 days a year with temperatures below freezing. The low temperatures rarely last more than a day or two. They usually come in January, with NE. or E. winds, the mountains often being snow-covered at the time. The highest thermometer readings of summer ordinarily reach about 100°–105°, and in the Jordan Valley, 110°. Absolute maxima may run a few degrees higher. Jerusalem has had 108°; Tiberias, 114°, and 122° is said to occur in the lower Jordan Valley. The high summer temperatures occur with hot, dry easterly and southerly winds.

Taking the year as a whole, the prevailing winds of Palestine are westerly. In winter, NE., E., and also SE. directions are frequent; in summer, W. and NW. directions are dominant. The character of the winds depends on the season. The westerly winds are naturally the dampest; the easterly are the driest. In summer, the westerly and northwesterly winds, blowing on to a warm land, are relatively damp, cool and refreshing. They are not rainy, and bring few clouds. The SE. wind of summer, on the other hand, is very dry, hot, depressing and disagreeable. It brings the highest temperatures, and is

¹⁰ The foregoing temperatures are purposely given in "round numbers," for the sake of simplicity. The essential temperature data, for representative stations, are accurately given in the following table:

| | Station | January | August | Year | Mean Max. | Mean Min. |
|-------------------|----------------|---------|--------|-------|-----------|-----------|
| Coast..... | Beirut..... | 54.4° | 81.5° | 68.9° | 95.2° | 39.0° |
| | Gaza..... | 53.1 | 79.7 | 67.5 | 100.4 | 42.4 |
| Hill Country..... | Nazareth..... | 49.1 | 77.2 | 65.3 | 106.2 | 32.4 |
| | Jerusalem..... | 44.6 | 73.4 | 60.6 | 97.2 | 29.0 |
| | Hebron..... | 43.3 | 72.5 | 59.7 | 98.8 | 26.6 |
| | Tiberias..... | 54.7 | 86.9 | 72.5 | 110.5 | 38.5 |

often dusty. It therefore closely resembles the Italian *sirocco*. At Jerusalem, 80 per cent. of all the winds blow from W. and NW., and the trees are wind-blown towards the SE., while in winter only 37 per cent. come from those quarters. During the colder months, winds from the E. and NE. are generally dry and exhilarating, but may become so sharp as to be unpleasantly chilling. Autumn and winter storms cause inflows of warm, damp, rain-bringing air from the SW., but "storm winds," in the sense of winds of high velocity, are rare, and occur mostly on the northern coast and at the higher elevations.

Accounts of the climate of Palestine usually emphasize the summer "sea-breeze" as contributing largely to man's comfort during the hottest part of the year. This damp, cooling and refreshing wind blows almost every day along the coast, beginning about 9-10 A.M., and usually reaching Jerusalem about 2-3 P.M., or a little later. After sunset, the sea-breeze usually dies down, but soon springs up again and blows most of the night, making these hours cool and comfortable. When the sea-breeze does not blow, the nights are very hot and unpleasant. It not infrequently happens that this wind fails to blow as far as Jerusalem (about 2,500 ft. above sea level). In such cases, that city has an uncomfortably hot night, while Jaffa, for example, at sea level, is kept cool by the fresh breeze from the sea.

Palestine rejoices, as do Italy and Greece and northern Africa, in the deep blue of the sky; the clearness of the air, the small amount of cloud. The cloudiest season is the winter, while the summers are remarkably clear.¹¹ The coast is somewhat more cloudy in summer than the interior. Heavy dews are characteristic of the plateau districts, the moisture being supplied by the wind from the sea. The ground is well wet with it, and it even drips from the tent-roofs. Fogs occur at night when the air is sufficiently damp. Jerusalem averages about 15 fogs a year. These are nocturnal, and come in summer. On the coast, also, fogs are noted with about the same frequency.

As stated above, the winter in Palestine is the rainy season. These rains fall in connection with general storms, which come from the Mediterranean. These are similar to but less marked than our own winter storms. The winter rains of Palestine are essentially like those of southern California,

¹¹ Mean January cloudiness 40-50 per cent. Summer cloudiness generally below 10 per cent. Jerusalem has a mean cloudiness as follows: winter, 50 per cent.; spring, 40 per cent.; summer, 10 per cent.; autumn, 25 per cent.; year, 31 per cent.

of northern Africa, of central Chile. In regions such as these, where the summers are very dry, the amount and distribution of the annual rainfall is the critical control of crops, of water supply, and of the general economic condition of the people. The rainfall at Jaffa and Saron, and at Gaza, on the coast, is between 15 and 20 inches (In the north, Beirut has over 35 inches). In the hill country, the amounts are a little over 25 but less than 30 inches. In northern Syria, the mountains of Lebanon have as high as 50 in. In the eastern depression, Tiberias has just under 20 inches.¹²

As in all subtropical climates, there are marked fluctuations (15 per cent. to 20 per cent. and over) in the amount of rain which falls in different years. These conditions influence the crop yield, and naturally cause constant anxiety throughout the population. The cause of these fluctuations is doubtless to be found in the varying seasonal distribution of pressure over the eastern Mediterranean and the adjacent land areas. It is an interesting fact that the earliest known rainfall measurements were made in Palestine in the first century A.D. The annual amount at that time was the same as it is at present. The average monthly percentage distribution of rainfall is shown in the following table:

| Jan. | Feb. | Mar. | Apr. | May | June | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. |
|--------------------------|------|------|------|-----|------|------|------|-------|------|------|------|
| 25.3 | 17.0 | 12.0 | 4.9 | 1.1 | 0.0 | 0.0 | 0.0 | 0.2 | 2.4 | 12.3 | 24.8 |
| (Mean Annual: 24.40 in.) | | | | | | | | | | | |

About one half of the total annual rainfall usually comes in December and January. These months have both the largest amounts and also the greatest frequency of rain. The "rainy season" proper may be said to extend from the middle of October to early in May. The "normal" rainy season covers the periods noted below at four representative stations.

| | |
|-----------------|----------------|
| Beirut | Oct. 3-May 21 |
| Saron | Oct. 18-May 12 |
| Jerusalem | Oct. 14-May 6 |
| Tiberias | Oct. 24-May 3 |

¹² MEAN ANNUAL RAINFALLS IN PALESTINE.

| Station | Approximate Altitude (Ft.) | Amount (Inches) |
|-----------------------|-------------------------------|--------------------|
| Jaffa and Saron | 130..... | 20.47 |
| Gaza | 65..... | 16.53 |
| (Beirut | 115..... | 35.67) |
| Nazareth | 1600..... | 27.09 |
| Jerusalem | 2460..... | 26.02 |
| Hebron | 2900..... | 25.63 |
| Tiberias | — 660..... | 19.17 |

The duration is about 200 days at the hill stations (*e. g.*, Jerusalem and Nazareth),¹³ but this may vary greatly (80–90 days) from year to year. Six months are often practically rainless, but occasional rains do fall in the dry season. In Jerusalem, the rainy season has begun (10-year record) as late as mid-November, and has ended as late as early April. People begin to talk about the coming rains as early as September, and become increasingly anxious as the date of their beginning is retarded into November. There is also considerable variation in the rainfall of the same month in different years. At Jerusalem, for example, it is reported that the January rainfall of one year was 13.39 in., and of another year .12 in., a variation of about 100 per cent. The rains do not as a rule fall steadily on several days in succession, but are interrupted, after a short stormy spell, by intervening periods of fine, thoroughly enjoyable weather. The average number of rainy days a year decreases from north to south along the coast (60 in north; 40 in south); is about 60 on the highlands, and about 50 in the Jordan Valley. Occasional unusually heavy rains cause floods. The terms “former” and “latter” rains, which are used in the Bible, refer to the importance of earlier and later rains in relation to crops. The early rains, of late autumn and early winter, moisten the soil and put it in proper condition for seeding. The water supply of the year, upon which people depend to replenish springs, fill cisterns and supply rivers, comes with the heavy rains of winter. The later, and lighter, rains of spring bring the crops to maturity.

Snow is rare on the coast, but falls on the hills two or three times a year. It has snowed as late as April. Snow seldom lies more than twenty-four hours on the ground. In 22 “rainy seasons” at Jerusalem, 14 brought some snow. In Jerusalem itself there is an average of three days a year with snowfall. Occasional unusually heavy snowfalls are reported. Thus, on December 28–29, 1879, nearly 17 inches fell. In February, 1874, the snow was 8¼ inches in depth. In February, 1898, Hebron had snow from 10 to 13 inches in depth. In mid-March, 1910, there was snow in Jerusalem 8 inches deep. Hail is often mentioned in the Bible. Thunderstorms occur chiefly in autumn, late winter or spring. Jerusalem averages 7.4 thunderstorm days a year, and 2.7 days with hail.

The late Professor A. J. Herbertson gave the following excellent brief summary of the climate and products of Syria and Palestine:¹⁴

¹³ 230 days at Beirut.

¹⁴ “The Senior Geography,” Oxford, 1907, pp. 24–25.

On the Mediterranean slopes and on the hills of Gilead, beyond Jordan, the rainfall is sufficient for agriculture. The climate is that of southern Europe. The plains make rich wheat lands. The vine, olive and fig are grown on the hills, but the old careful terrace cultivation has fallen into decay. The climate of the Jordan rift is very hot. Jericho, on the main eastern route from Jerusalem, is still surrounded by palm trees and groves of bananas and oranges. East of Jordan the summer heat increases, and the rainfall diminishes. The country is poor grass land, passing into desert. Ruins of cisterns, tanks, and cities show that it was once irrigated and cultivated. It is now the home of wandering Arab tribes, who keep camels, sheep and goats.

Like other subtropical countries, with a "Mediterranean" climate, Palestine is green and fresh and inviting during its rainy season, but its summers bring drought, and dust, and heat, and its vegetation dries up. As in Mesopotamia, so here. An honest, efficient, progressive government, with careful plans for the future of the country, could by means of education in the best agricultural methods, and by an extensive system of irrigation, make of much of Palestine a rich garden, full of many fruits and other products which find their most favorable conditions of growth in just the climate which is there provided.

Into the climatic conditions which have here been briefly described, the British Army advanced, from the south, in the spring of 1917, having, according to reports, first built a railroad across the Sinai Desert for the transportation of troops and supplies. The season selected for this invasion was the most favorable in the year, for after the winter rains food for both men and animals is then most abundant; occasional showers refresh the ground; the heat is not as great as it is later on, nearer the summer. The reports regarding the Palestine campaign have been very meager, but as far as they go they have laid emphasis upon the part played by meteorological conditions. The first distinct success was the capture of Gaza, a place selected in the foregoing climatic description as representative of the southern coast. On April 2, 1917, Mr. Bonar Law said in the House of Commons that the operations against Gaza were most successful, and if it had not been for a fog which delayed the attack, and a shortage of water, complete disaster would have overtaken the Turks. Major Gen. F. B. Maurice, on April 5, 1917, confirmed this statement when he said that complete British success was only prevented by "a thick seven hours' sea fog." It is an interesting fact that two climatic conditions, fog and lack of water, played so important a part at the very beginning of the British operations in Palestine. A Constantinople despatch dated April 26, 1917, reported that Turkish (doubtless German) airmen on the Sinai front had

totally destroyed the water-supply system which the British had constructed for their troops. The capture of Gaza was followed by that of Jaffa, Beersheba and of other less important places. The British advanced more rapidly as soon as the hot, dry summer was over, and the cooler autumn weather, with occasional showers, favored military operations. In the light of what was said above regarding the beginning of the rainy season, it is an interesting fact that the official reports mention "heavy rains," and "bright, cold weather," at the end of November (1917). This is the first mention of rain. The date is very late in the season for the actual beginning of the rains, and doubtless refers to rainfalls so heavy that they attracted attention, and possibly interfered somewhat with the movement of troops and supplies.

Jerusalem fell early in December. It is not an unlikely supposition that General Allenby planned to take that city before the December rains set in. This month usually contributes, as has been seen above, about one quarter of the total annual rainfall. A correspondent with the British troops reported of the weather conditions accompanying the march against Jerusalem:

A torrential rain made the roads impassable, while a chilly east wind¹⁵ pierced the sodden soldiers to the bone. The problem of supply and transport almost drove us to despair. The camels were unable to keep a foothold on the slippery paths. Nevertheless, the food and ammunition supply was maintained fully.

Further emphasis upon the handicaps resulting from the winter weather conditions of Palestine was laid by Major Gen. F. B. Maurice when he said (January 2, 1918)

A word of caution is necessary relative to the hopes of an immediate further advance in Palestine. The hills of Judæa are notoriously difficult. The weather is unfavorable, and the roads are impossible owing to the wet season. The transport problem, therefore, is likely to prevent any considerable movement there for some time.

The capture of the Holy City, which naturally produced a great outburst of religious enthusiasm, was of immediate practical significance to the British Army. A strong line of positions had been secured. A good water supply was available. Difficulties of terrain, of weather, and of hard fighting had been overcome. The troops all felt that they "had the Turk beaten."

The Palestine campaign is closely associated with the fighting for the possession of the Suez Canal. For the capture of Palestine by the British is one essential in the protection of the Canal against invading armies. It is, therefore, appro-

¹⁵ This is the coldest wind in winter.

priate that some mention be made here of the fighting which took place, earlier in the war, in the district just east of the Suez Canal. Much was written, in the early months of the war, about the probable invasion of Egypt by the Teutonic Allies. Many contradictory and erroneous statements found their way into print. It was reported that the Turks, with the assistance of German engineers, were pushing a railroad toward Suez, "over 150 miles of desert," and were paralleling it with a pipe-line for water. These mains were to be laid from the nearest wells, and the water was to be driven by powerful pumps. Openings were to be provided at frequent intervals to supply the troops during their march. There was also a report that German engineers were prospecting for water all through this region as far back as 1912. Even with the known, very serious, handicaps of the desert clearly in mind, there is nothing inherently impossible in the construction of such a railroad and in providing water by means of tank cars or pipe line, and food. A far more serious problem than that involved in the construction of a railroad across the Sinai desert has recently been solved in the successful completion of the new transcontinental Australian railroad. In the case of such an invasion of Egypt, the greatest difficulties would pretty surely be encountered in the transportation, feeding and munitioning of the troops over such very inferior railways as those of Asia Minor. As to the water-supply available for a large army during its progress across the desert it is, of course, at present impossible to make definite statements. At the eastern end of the Mediterranean the rainfall along the coast averages somewhat over 20 inches a year. The amount decreases to the south and west, so that even on the west, in the country which an invading army might cross, less than 10 inches fall annually. This is a winter rainfall. Hence winter would be the best season for such a campaign, both on account of the better water-supply and of the lower temperatures. Both seasonal and annual rainfalls are subject to great fluctuations, and can not be predicted in advance. The supply is variable, very scant at best, and very precarious, especially when the needs of the transport animals, as well as of the men, are taken into account. The climatic obstacles are not insuperable, but they are serious. To transport a large body of troops across a desert to a fighting ground in the midst of an arid wilderness, facing the British troops with Egypt close at their backs, presented a problem which even the highly efficient German military staff might have some doubt about solving. In order to

reduce the water requirements of the many transport animals which would otherwise be needed, the Germans considered the use of air-cooled motors for moving their artillery and supplies across the desert. In spite of its many disadvantages, a desert does possess one great advantage from the point of view of health: its air is dry and aseptic. Under any ordinary conditions of proper sanitation, widespread epidemic diseases would not be likely to occur. A strong Turkish movement, with heavy artillery, against the Suez Canal was bound in any case to be difficult and slow. Of all the obstacles which may stand in the way of a marching army, a desert, whether it be a desert of sand or a desert of snow, is one of the greatest.

The official reports of the fighting for the Suez Canal were brief and generally unsatisfactory from the point of view of the present discussion. Moreover, there was a lack of the excellent war correspondents' letters, which have thrown so much light on the campaigns in the major war areas in Europe. The essential facts regarding the campaign for the Canal, in so far as they illustrate weather controls, are briefly as follows: Turkish activity near the Canal began toward the end of January, 1915, the enemy clearly realizing that the Sinai desert is more readily crossed in winter than in the heat of the summer. In expectation of the coming of the Turkish troops, the British had filled up many wells in the desert. After the German drive through the Balkans, early in the winter of 1915-16, and the opening of communication between Berlin, Vienna and Constantinople, a Turko-German attack on the Suez Canal was expected in the favorable months of January, February and March, "when white men may manoeuvre in the desert." This attack did not materialize. A Turkish attempt to reach the Canal early in August, 1916, failed completely. The troops advanced in the face of the greatest difficulties. The men were transported on camels. For the guns, small parallel trenches were dug, to fit the wheels of the gun carriages. These trenches were filled with scrubby plants, and in some places, where the sand was too loose and deep for the track, planks were laid lengthwise under the wheels. Water was carried on the backs of camels and of donkeys. The Turkish despatches mentioned a "gigantic sandstorm," which impeded their left wing. Taking advantage of this phenomenon, the British made a successful surprise attack. The routed Turks met terrible hardships. In some cases the men were reported to have suffered so much from thirst that they killed their camels for water, and even drank the blood.